J TOTAL MERCURY AND TSS CONCENTRATION TIME SERIES PLOTS FOR MAJOR DELTA TRIBUTARY INPUT AND EXPORT LOCATIONS AND LOAD AND CONFIDENCE INTERVAL CALCULATION METHODS

Section J.1 provides figures that summarize available total mercury and TSS concentration data for monitoring stations. Section J.2 describes load and confidence interval calculation methods for tributary locations with statistically significant total mercury and/or TSS concentration/flow regressions and includes linear regression plots for the stations with statistically significant regressions. Section J.3 describes load and confidence interval calculation methods for tributary sampling locations without statistically significant concentration/flow regressions. Section J.4 describes the error propagation calculation methods for the mass balances presented in Chapter 7.

J.1 Total Mercury and TSS Concentration Time Series Plots

Figure J.1a: Available Total Mercury Concentration Data for the Mokelumne River, Prospect Slough and San Joaquin River.

Figure J.1b: Available TSS Concentration Data for the Mokelumne River, Prospect Slough and San Joaquin River.

Figure J.2a: Available Total Mercury Concentration Data for the Sacramento River.

Figure J.2b: Available TSS Concentration Data for the Sacramento River.

Figure J.3a: Available Total Mercury Concentration Data for Small Westside and Eastside Tributaries.

Figure J.3b: Available TSS Concentration Data for Small Westside and Eastside Tributaries.

Figure J.4a: Available Total Mercury Concentration Data for Major Delta Exports.

Figure J.4b: Available TSS Concentration Data for Major Delta Exports.

Figure J.5a: Available Total Mercury Concentration Data for American River, Cache Creek, Colusa Basin & Feather River Watershed Outflow Locations.

Figure J.5b: Available TSS Concentration Data for American River, Cache Creek, Colusa Basin & Feather River Watershed Outflow Locations.

Figure J.6a: Available Total Mercury Concentration Data for Natomas East Main Drain, Putah Creek, Sacramento Slough (Sutter Bypass) & Sacramento River above Colusa Watershed Outflow Locations.

Figure J.6b: Available TSS Concentration Data for Natomas East Main Drain, Putah Creek, Sacramento Slough (Sutter Bypass) & Sacramento River above Colusa Watershed Outflow Locations.
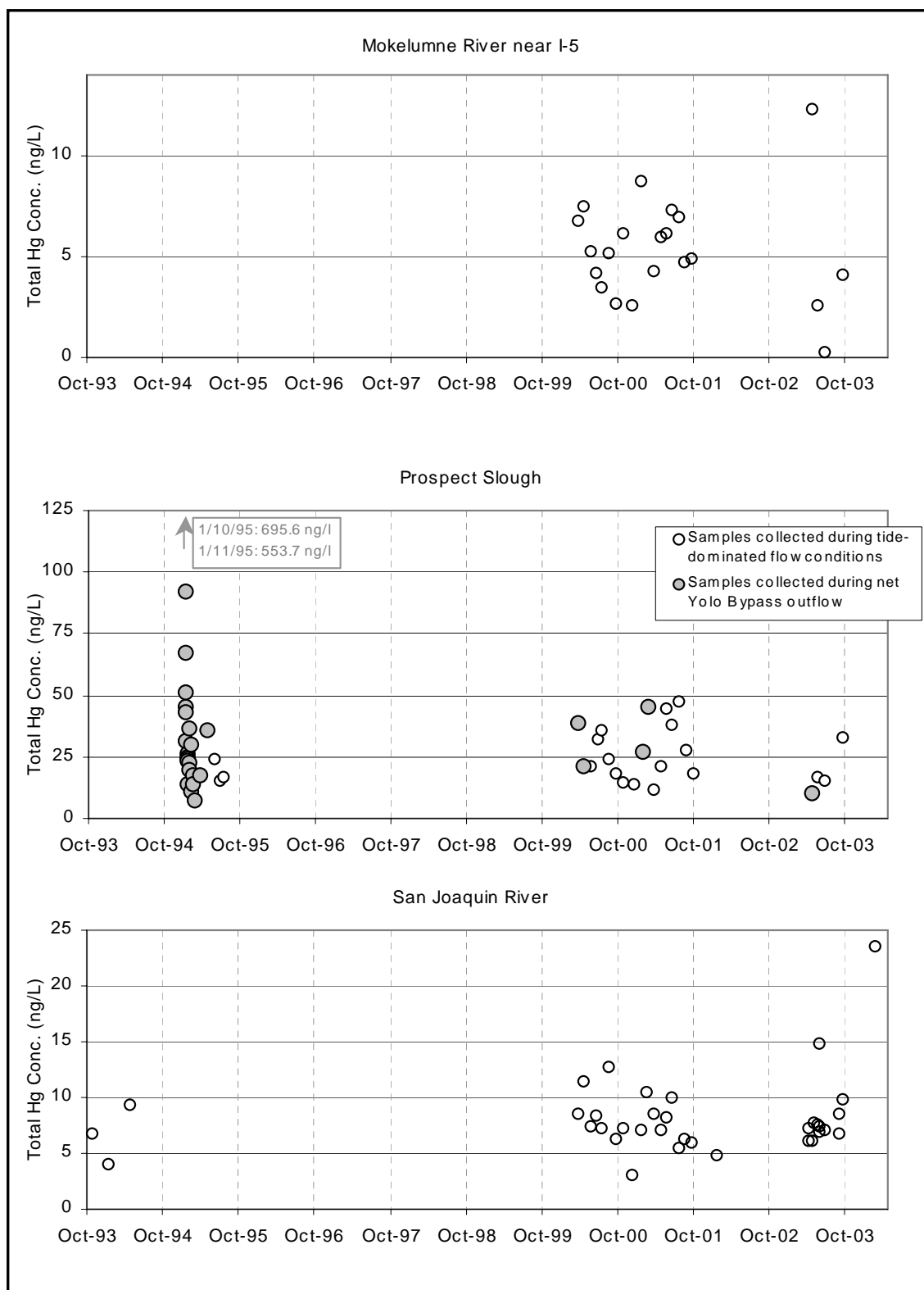
Figure J.1a: Available Total Mercury Concentration Data for the Mokelumne River, Prospect Slough and San Joaquin River.
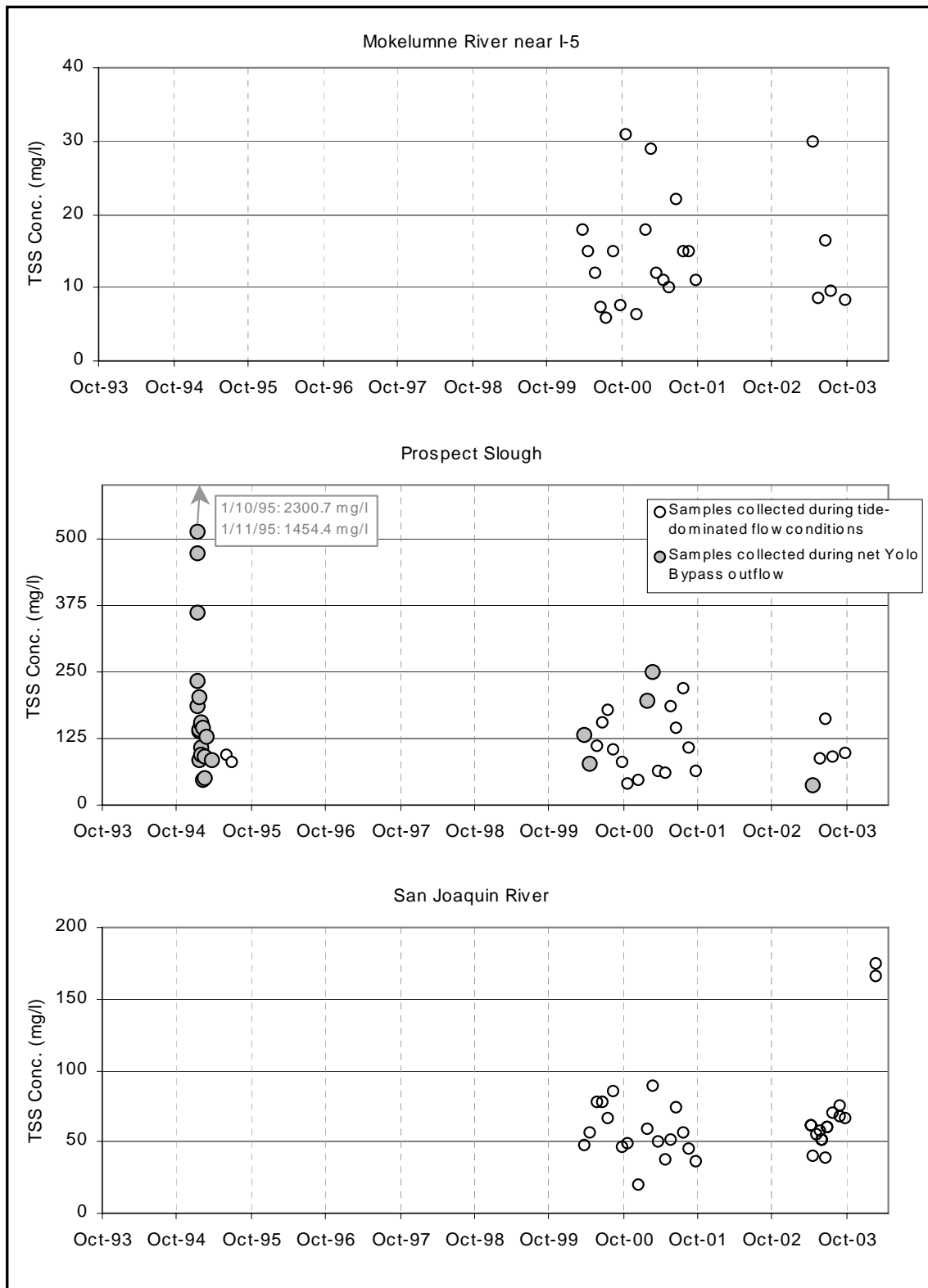
Figure J.1b: Available TSS Concentration Data for the Mokelumne River,
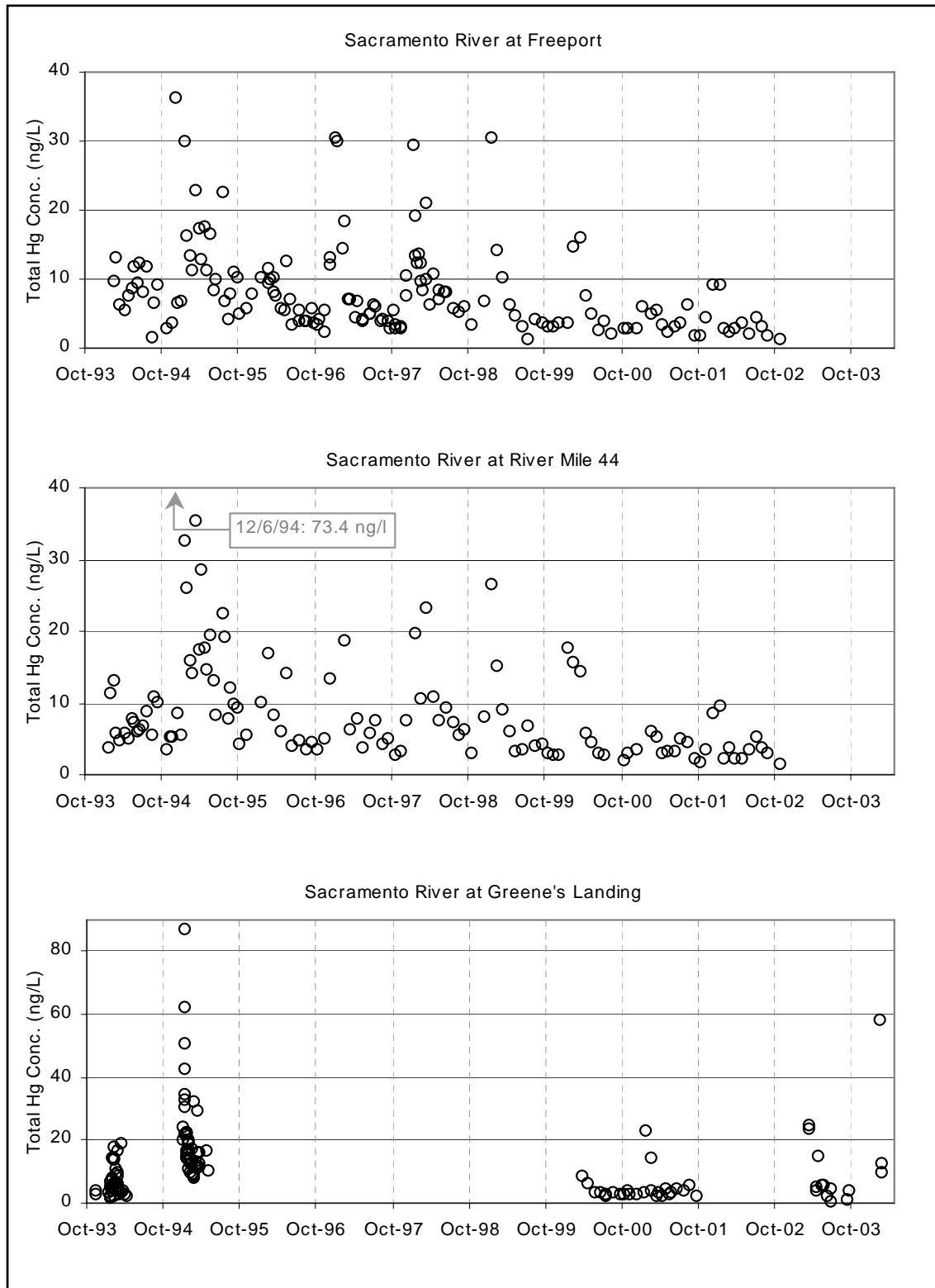Prospect Slough and San Joaquin River.

Figure J.2a: Available Total Mercury Concentration Data for the Sacramento River.
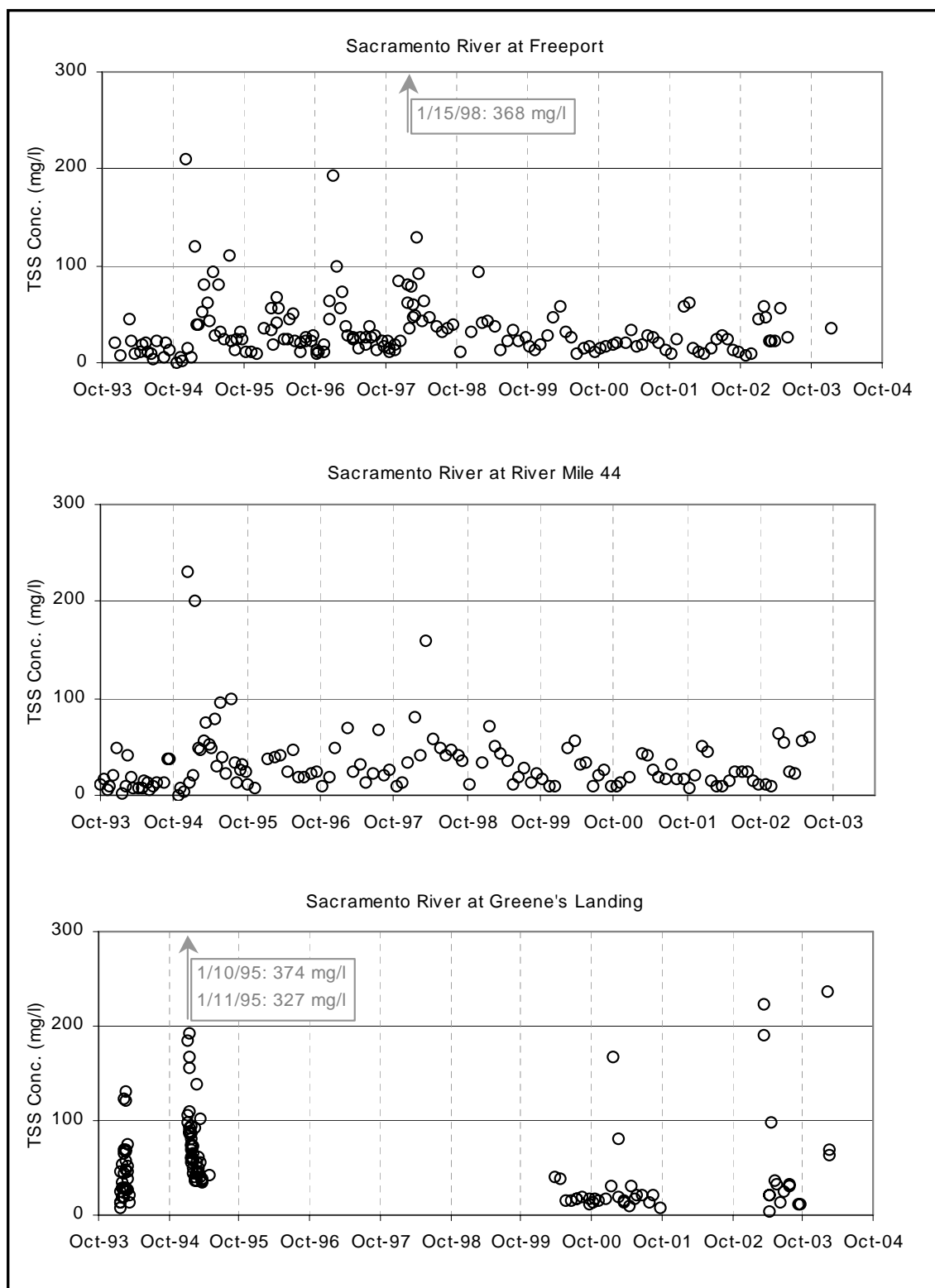
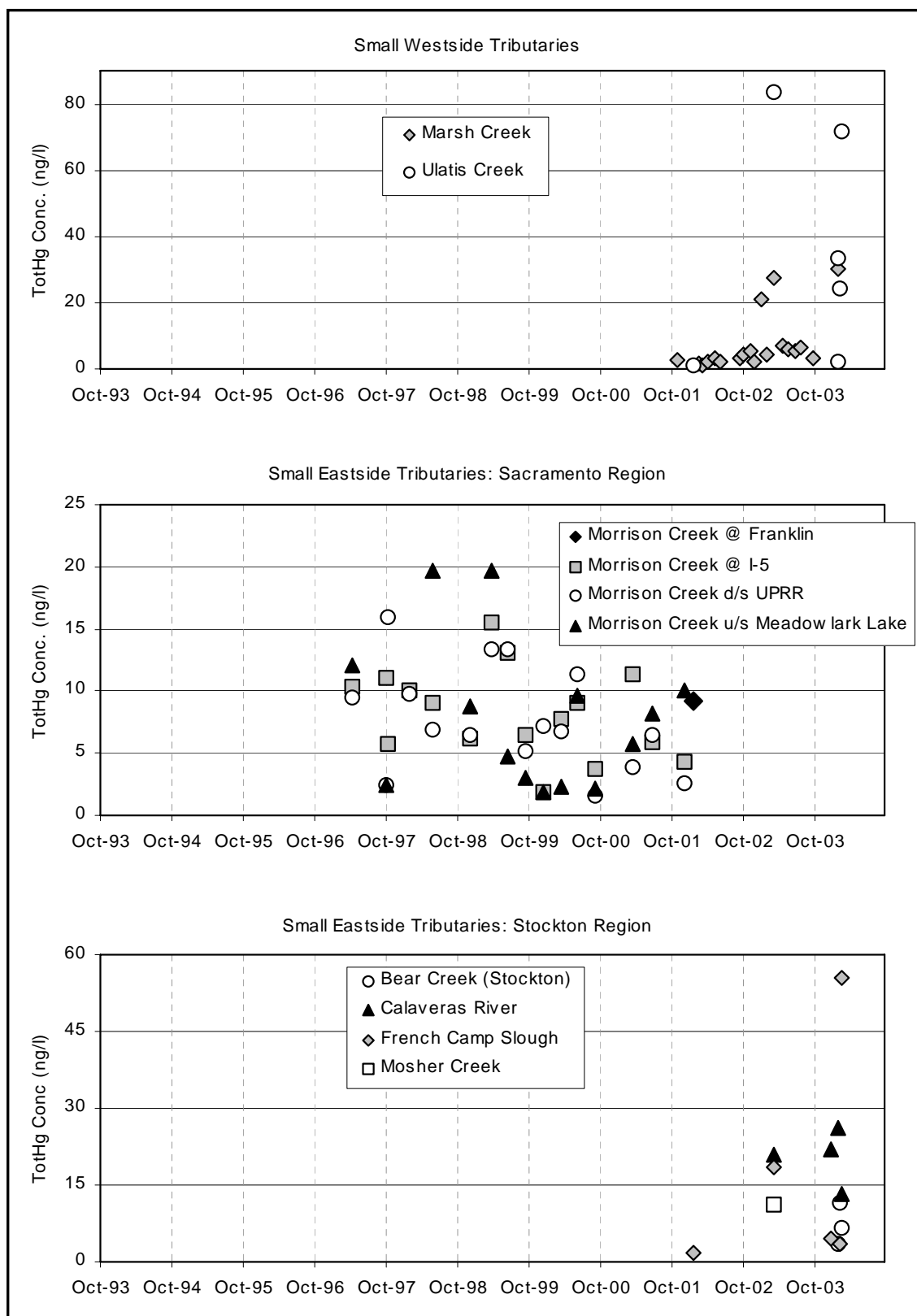Figure J.2b: Available TSS Concentration Data for the Sacramento River.

Figure J.3a: Available Total Mercury Concentration Data for Small Westside
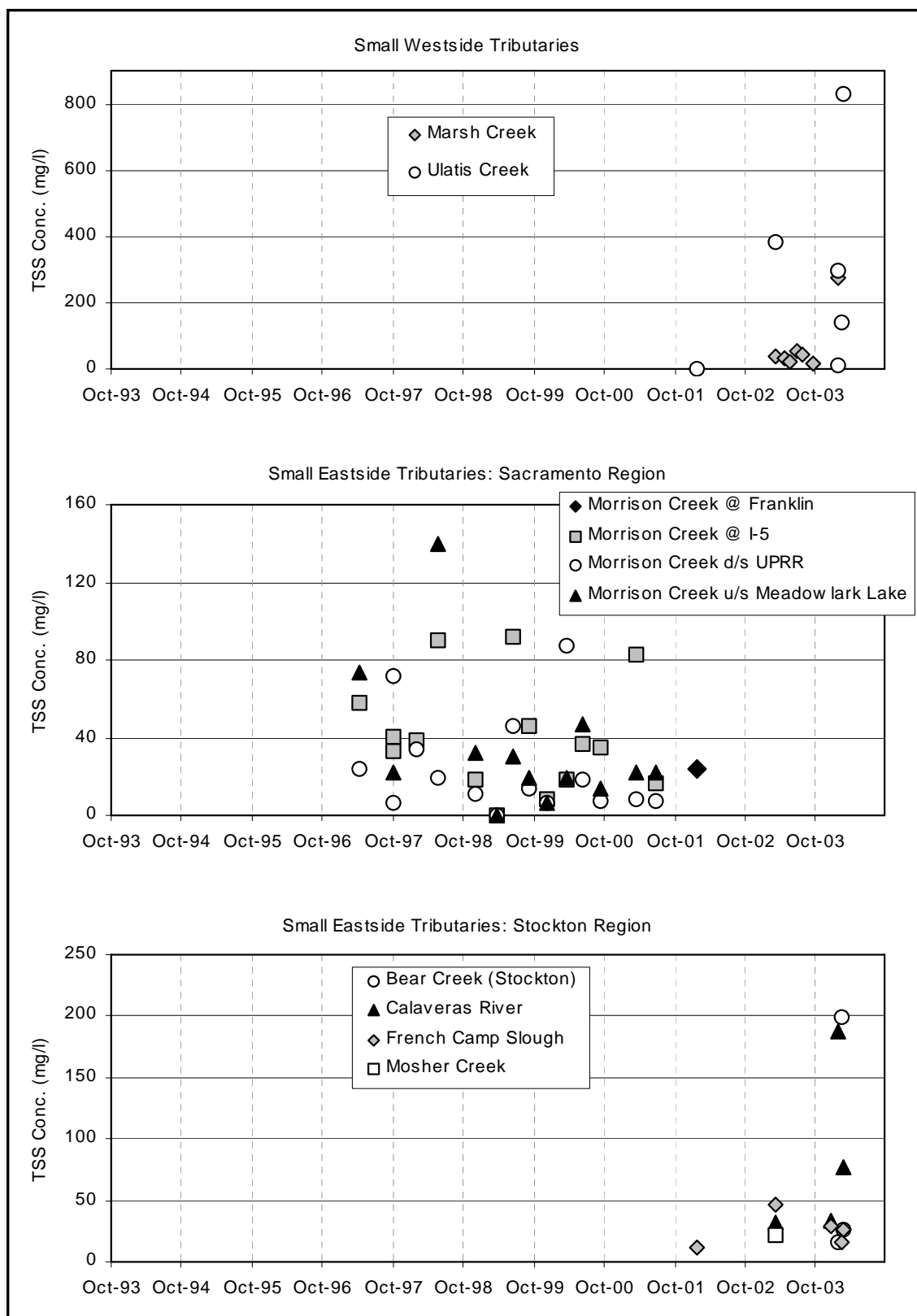and Eastside Tributaries.

Figure J.3b: Available TSS Concentration Data for Small Westside
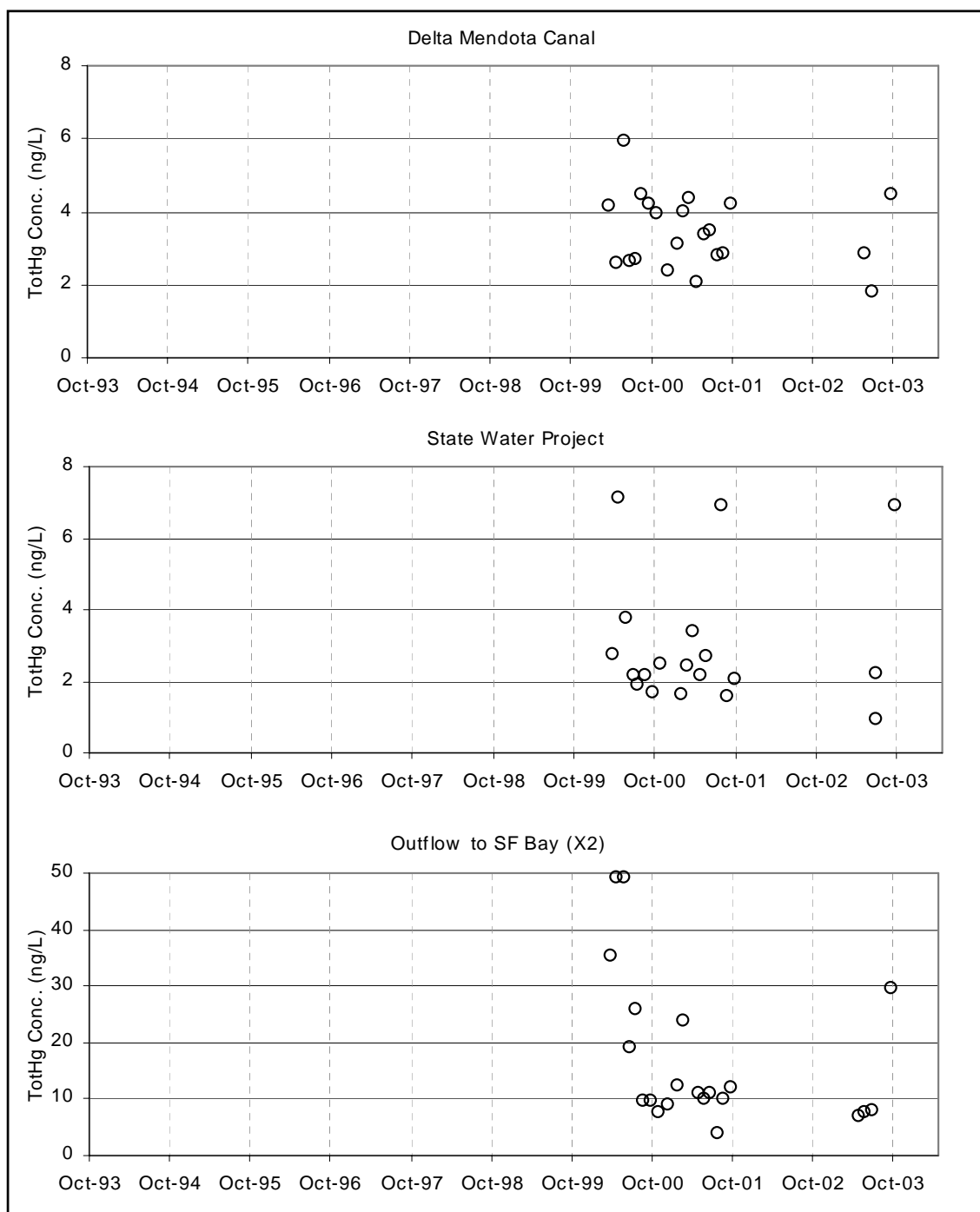and Eastside Tributaries.

Figure J.4a: Available Total Mercury Concentration Data for Major Delta Exports.
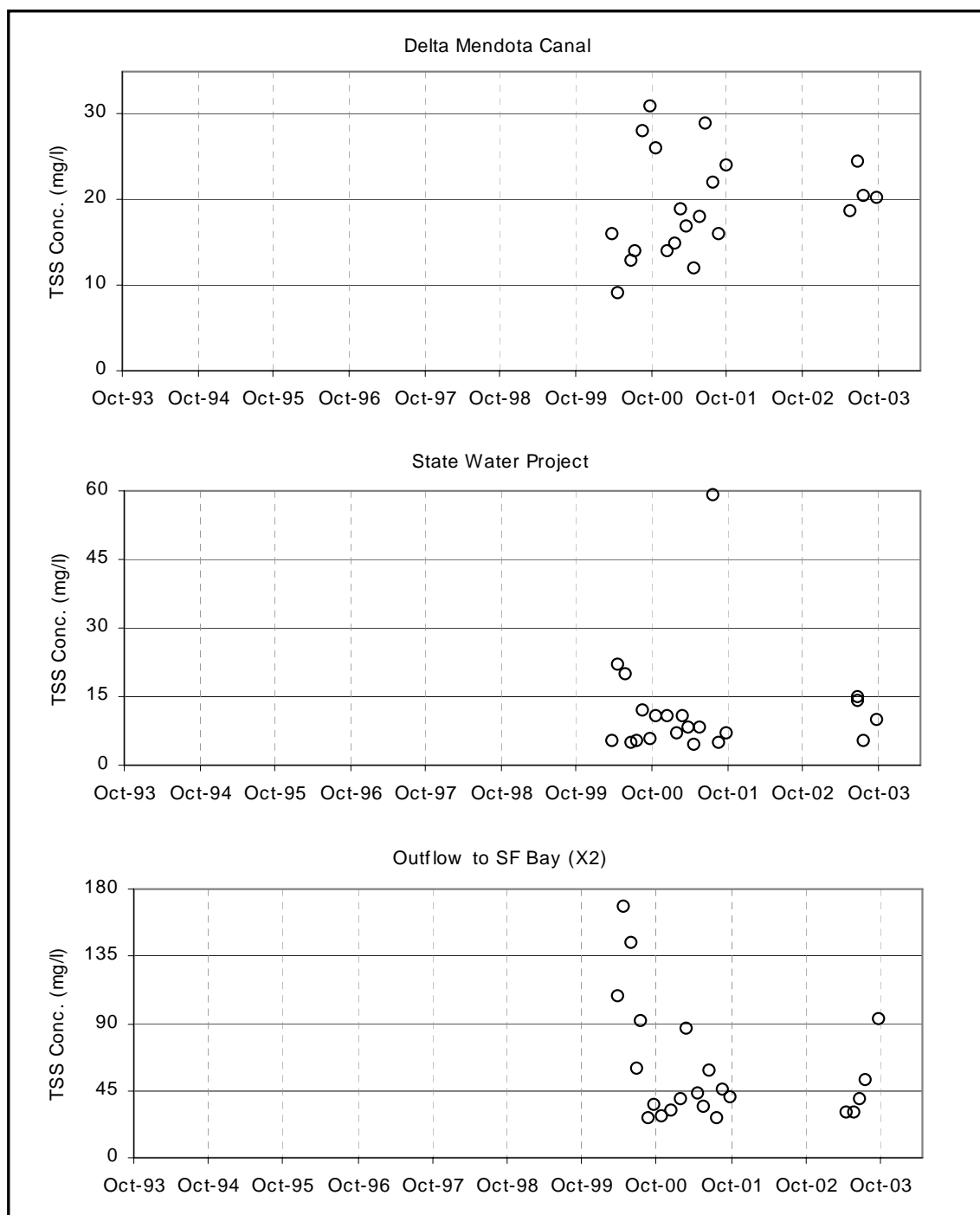
Figure J.4b: Available TSS Concentration Data for Major Delta Exports.

Figure J.5a: Available Total Mercury Concentration Data for American River,
Cache Creek, Colusa Basin & Feather River Watershed Outflow Locations.

Figure J.5b: Available TSS Concentration Data for American River, Cache Creek,
Colusa Basin & Feather River Watershed Outflow Locations.

Figure J.6a: Available Total Mercury Concentration Data for Natomas East Main Drain, Putah Creek, Sacramento Slough (Sutter Bypass) & Sacramento River above Colusa Watershed Outflow Locations.

Figure J.6b: Available TSS Concentration Data for Natomas East Main Drain, Putah Creek, Sacramento Slough (Sutter Bypass) & Sacramento River above Colusa Watershed Outflow Locations.

J.2   Average Annual Load and Confidence Interval Calculations for Tributary Sampling Stations with Statistically Significant Concentration / Flow Regressions

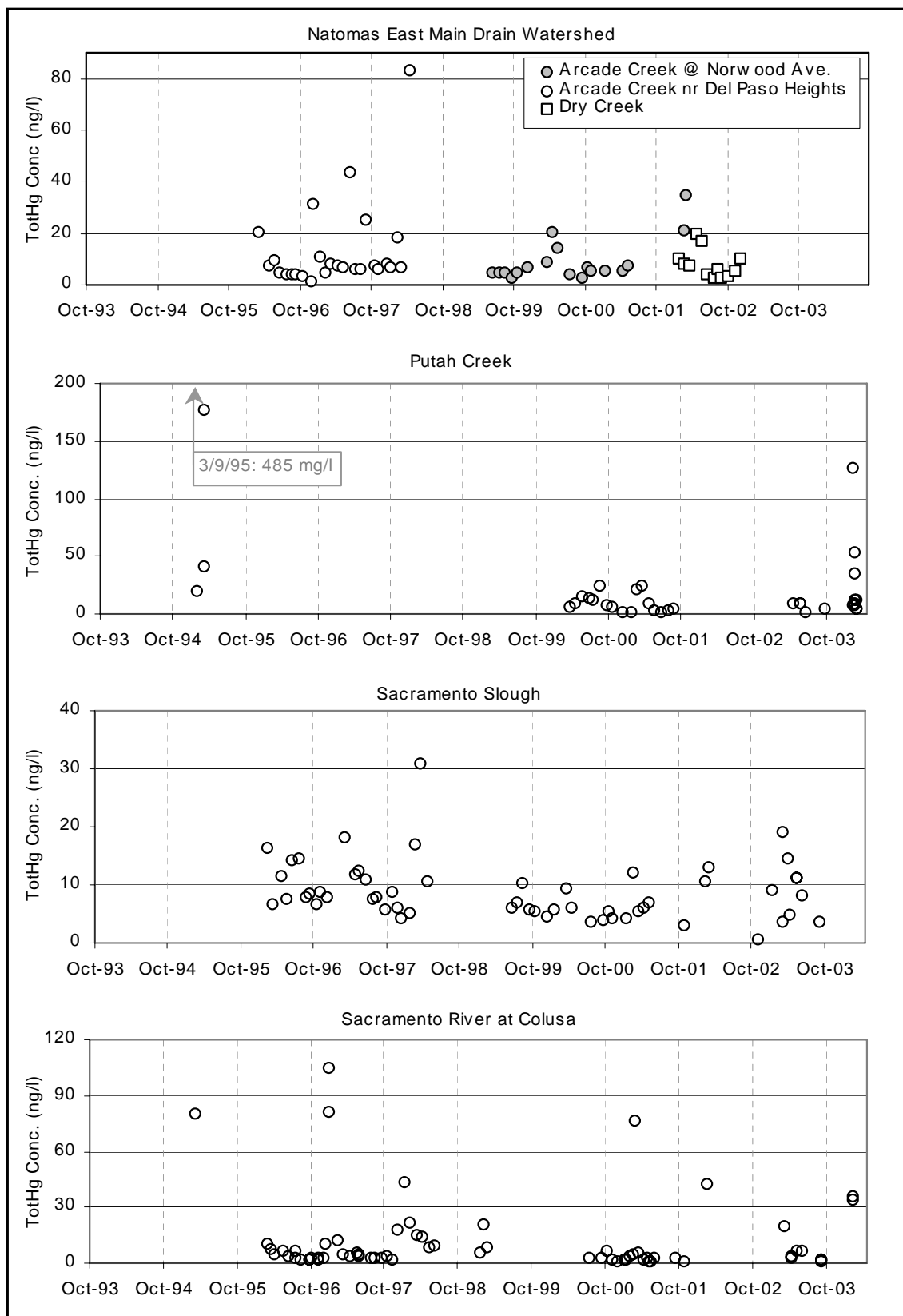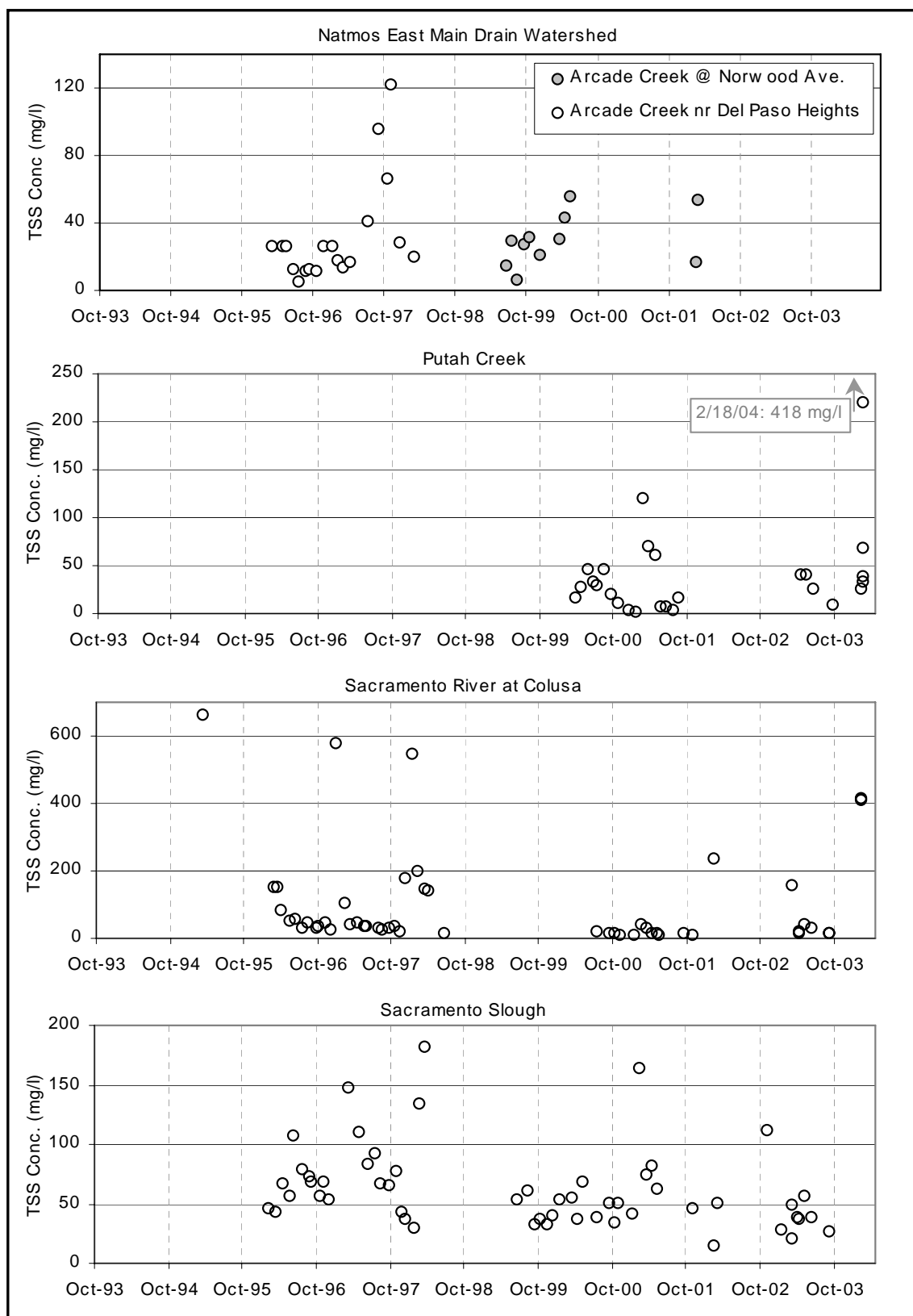Staff predicted the concentration of total mercury and/or TSS from flow for tributary sampling stations with significant (P < 0.05) concentration/flow linear regressions (Table J.1 and Figures J.7a and J.7b). Daily mercury and/or TSS concentrations were predicted for each tributary for two periods: WY2000-2003 and WY1984-2003. Daily loads were calculated by using daily average flow data (Appendix E). Average annual loads were calculated using Equation J.1.

Equation J.1:

$$\text{Average Annual Load} \quad = \quad \frac{1}{H}\sum c_i \bar{Y}^* + \frac{b_1}{H}\sum c_i (X_i - \bar{X}^*)$$

Where:

H	=	Number of years being averaged (20 or 4 years)
c_i	=	Constant of proportionality
$\bar{Y}^*$	=	Average concentration (i.e. Total mercury or TSS) of the data used for the regression
b_1	=	Slope derived from the linear regression
X_i	=	Daily average flow (cfs) from the flow record for 20 or 4 years
$\bar{X}^*$	=	Average of the daily average flow of the data used for the regression

The variance of the average annual loads is calculated from Equation J.2.

Equation J.2:

$$\text{Variance } (s^2) \quad = \quad \left(\frac{1}{H}\right)^2 \left(\sum c_i\right)^2 \left(\frac{\sigma^2}{n^*}\right) + \left(\frac{\sum c_i (X_i - \bar{X}^*)}{H}\right)^2 \left(\frac{\sigma^2}{\sum (X_i^* - \bar{X}^*)^2}\right)$$

Where:

H	=	Number of years being averaged (20 or 4 years)
c_i	=	Constant of proportionality
σ^2	=	Residual mean square (*MSE*) from the regression
n^*	=	Sampled population size of the data on which the regression was based
X_i	=	Daily average flow (cfs) from the flow record for 20 or 4 years
X_i^*	=	Daily average flow (cfs) of the data used for the regression
$\bar{X}^*$	=	Average of the daily average flow of the data used for the regression

From the variance, standard error is calculated using Equation J.3.

Equation J.3:

$$\text{Standard Error } (SE) \quad = \quad \left(s^2 \Big/ (n^* - 2)\right)^{1/2}$$

Where:

s^2 = Variance calculated by Equation J.2

n^* = Sampled population size of the data on which the regression was based

Using the above standard error, the confidence interval was calculated from Equation J.4.

Equation J.4:

Confidence Interval (*CI*) = Average Annual Load $\pm\ SE \times t_{\alpha,df}$

Where:

SE = Standard error calculated by Equation J.3

$t_{\alpha,df}$ = Critical t-value with the probability (α) of 0.05 and (n^* -2) degrees of freedom

This method was developed through communications with Professor Neil Willits at the University of California at Davis. All calculations were made using Microsoft Excel's Data Analysis ToolPak.

The method for calculating average annual loads and confidence intervals for tributary sampling stations without statistically significant concentration/flow regressions is described in Section J.3 after Table J.1 and Figures J.7a and 7.b.

Table J.1: Statistical Significance of Linear Regressions Between Concentration and Daily Flow at Tributary and Export Sampling Stations.

Sampling Stations (a)	Total Mercury/Flow Regression Statistically Significant (P < 0.05)	TSS/Flow Regression Statistically Significant (P < 0.05)
Delta Imports		
American River at Discovery Park	Yes	Yes
Cache Creek d/s Settling Basin	Yes	Yes
Colusa Basin Drain	Yes	Yes
Feather River	Yes	Yes
Mokelumne-Cosumnes Rivers	No	No
Putah Creek at Mace Blvd	No	Yes
Sacramento River at Colusa	Yes	Yes
Sacramento River at Freeport	Yes	Yes
San Joaquin at Vernalis	No	No
Marsh Creek	Yes	No
Prospect Slough (Yolo Bypass)	Yes	Yes
Export to San Francisco Bay Delta (X2 and Chipps Island)	No	No
Delta Mendota Canal at Byron Highway	No	No
State Water Project at Bethany Reservoir	No	No

(a) Bear, Mosher, Morrison and Ulatis Creeks, Calaveras River, Natomas East Main Drain, and French Camp Slough tributary stations were not evaluated because there are no flow gages near the stations. The flow gage near the Sacramento Slough station is not rated for high flows and is therefore not adequate for this analysis.
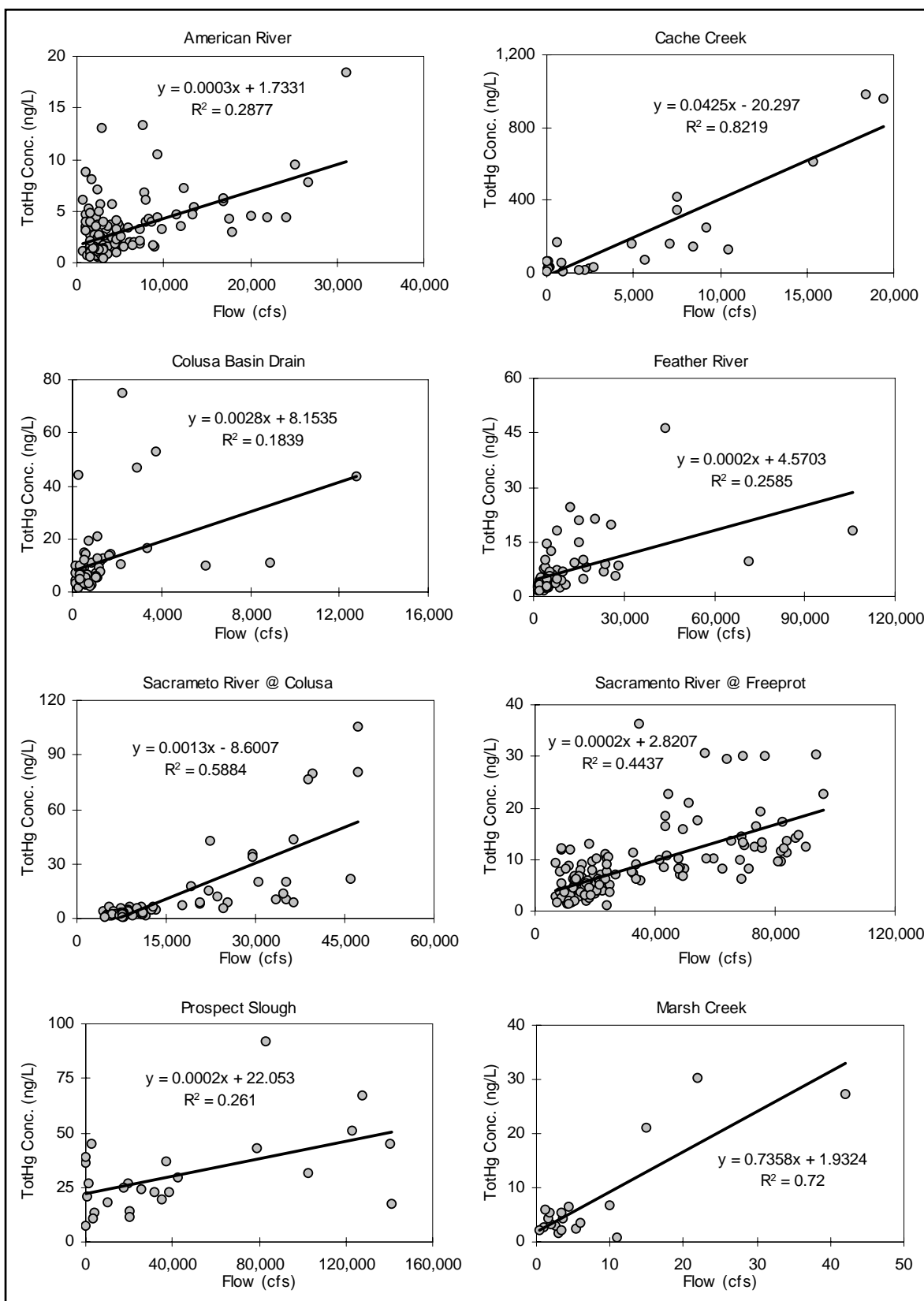
Figure J.7a: Total Mercury Concentration versus Daily Flow for Tributary Inputs With Statistically Significant (P < 0.05) Linear Regressions.

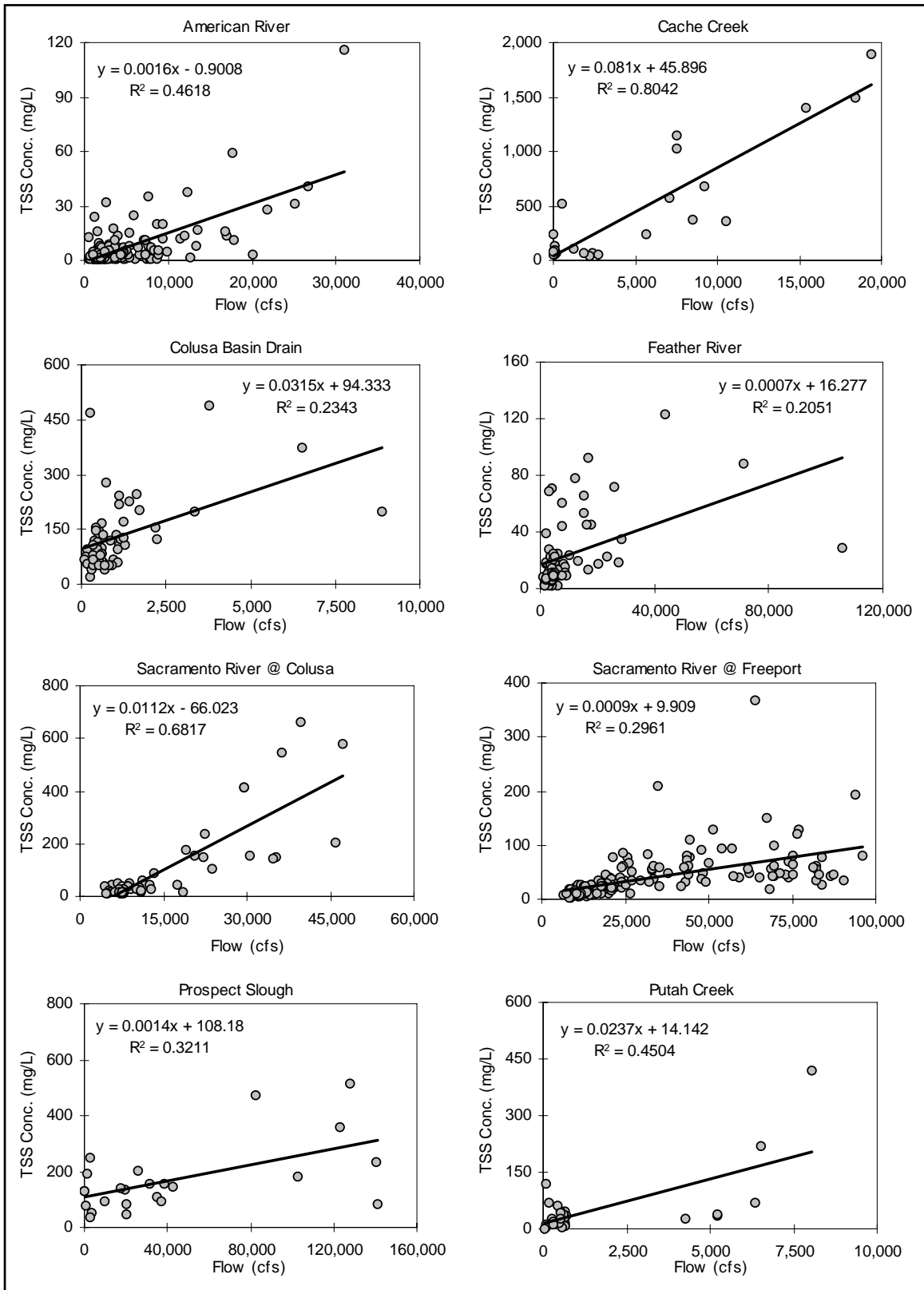Figure J.7b: TSS Concentration versus Daily Flow for Tributary Inputs With Statistically Significant (P < 0.05) Linear Regressions.

J.3 Annual Average Load and Confidence Interval Calculations for Tributary Sampling Stations without Statistically Significant Concentration / Flow Regressions

For the tributary and export sampling locations where linear regressions were not statistically significant (P < 0.05, see Table J.1), the daily loads for total mercury and TSS were calculated by multiplying the mean concentration for the sampled data by each water bodies' daily flow for two different periods: WY2000-2003 and WY1984-2003. Then the daily loads were summed (1461 days for 4 years or 7305 days for 20 years) and divided by the appropriate number of years to determine the average annual loads for each period. If the flow record was missing or unavailable for any number of days, then the sums of the daily loads were normalized to 7305 days for 20 years or 1461 days for 4 years before dividing by the number of years. For example, a 20-year record would be normalized by dividing 7305 (the number of days in the 20-year period) by the number of days with a recorded value in the flow record and then multiplying the resulting quotient by the calculated sum of loads; the result was then divided by 20 to obtain the average annual load.

To determine the upper and lower confidence intervals for the annual loads, the upper and lower 95% confidence limits of the concentration means, respectively, were multiplied by each water bodies' daily flow for 20 and 4 years, summed, and divided by the appropriate number of years.

The sampled data's concentration mean, standard error, and 95% confidence interval were calculated using the Microsoft Excel Data Analysis ToolPak option, "Descriptive Statistics".

J.4 Calculations for Error Propagation for the Mass Balances

To determine the confidence intervals of the mass balance components (i.e., sum of input loads or sum of export loads), staff determined the propagated error of the summed loads using Equation J.5 and the confidence interval for the summed loads using Equation J.6. This method was developed through communications with Professor Neil Willits at the University of California at Davis. All calculations were made using Microsoft Excel's Data Analysis ToolPak.

Equation J.5:

$$\text{Standard Error of Summed Loads } (SE_{all}) \quad = \quad \sqrt{\left(SE_{load_1}\right)^2 + \left(SE_{load_2}\right)^2 + \left(SE_{load_3}\right)^2 + ...}$$

Equation J.6:

$$\text{Confidence Interval of the Summed Loads } (CI_{all}) \quad = \quad \text{Summed Loads} \pm SE_{all} \times t^{*}_{\alpha,df}$$

Where:
SE_{all} = Standard error calculated in *Equation J.5*
$t^{*}_{\alpha,df}$ = Critical t-value with the probability (α) of 0.05 and (n_{all}-1) degrees of freedom.
$$n_{all} \quad = \quad \sum\left(n^{*}_{load_1} + n^{*}_{load_2} + n^{*}_{load_3} + ...\right)$$